SSDS Enables Safe Implementation of ERD Beneath Buildings

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Agenda

1 **Methane Properties**

2 **ERD Considerations**

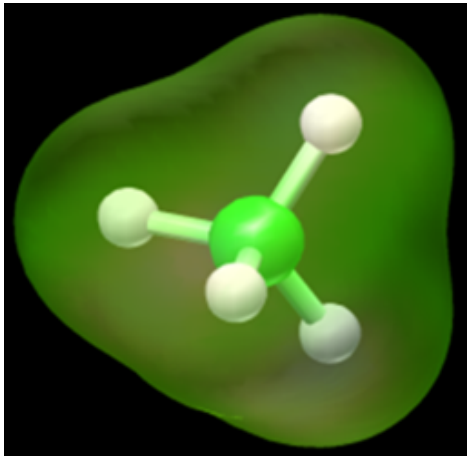
3 **SSDS Design Considerations**

4 **Case Studies**

Methane 101

Properties

- Odorless, colorless
- Need instrument to detect
- May be present at your site and you don't know it
- Non-toxic – no exposure criteria
- Lighter than air – very mobile
- Naturally attenuates in presence of O2
- Vertical attenuation
- Will not burn in soil
- Does not concentrate inside structures - will not be present in buildings at higher concentration than in adjacent soils



CH_4

Methane 101

Hazards

- Displaces oxygen
- Flammable when unconfined
- Explosive when confined
- Flammable range 5%v and 15%v

Image from blog.yaleappliance.com

Image from pnghunter.com

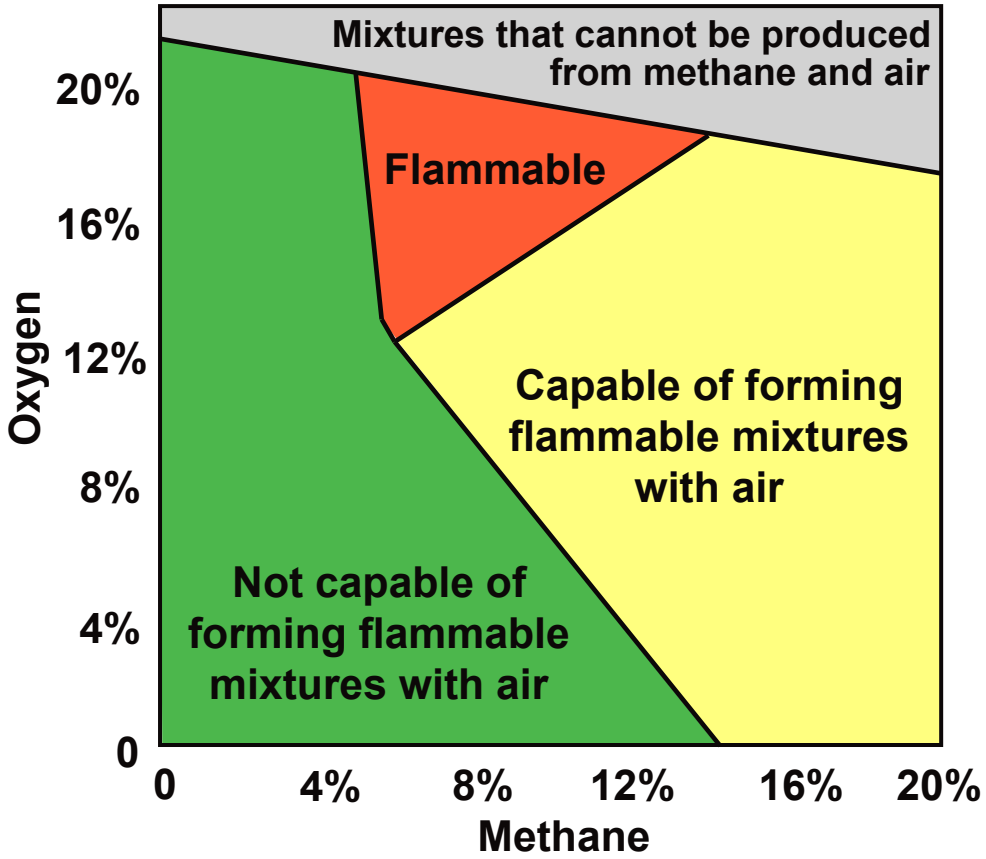


Figure source: 30 CFR 57.22003

Methane 101

Sources in the Sub-Surface

Anaerobic degradation of naturally occurring organic matter

- Peat
- Oil deposits

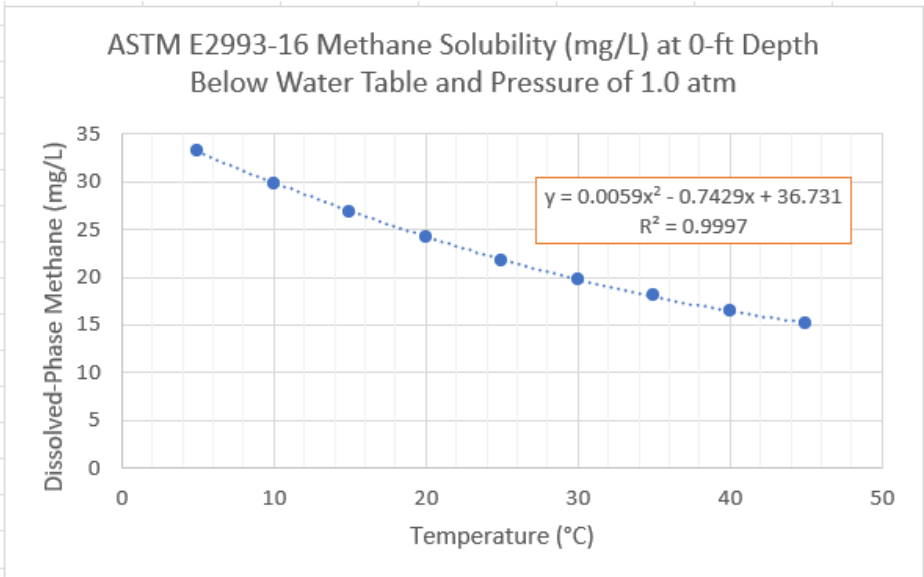
Anthropogenic sources

- Landfill gas
- Utility gas leak
- Petroleum impacts - LNAPL
- Remediation - ERD

Methane 101

Solubility in Groundwater

- Amount of methane that can be held in the dissolved phase
- Varies with depth (pressure) and temperature, 28 mg/L at STP
- Methane is released as a gas when pressure is decreased or temperature is increased

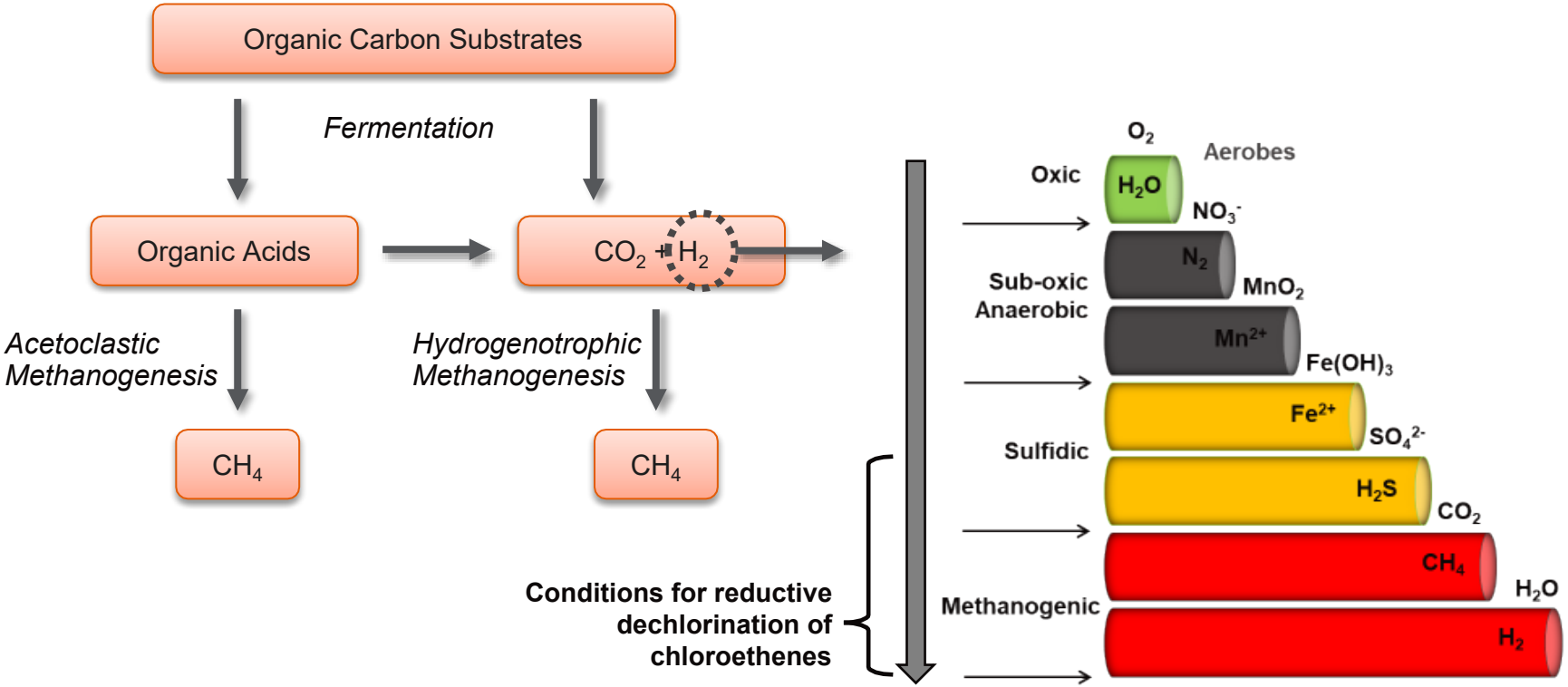


Similar to CO_2 release when opening a carbonated beverage

Image from istockphoto.com

ERD Considerations

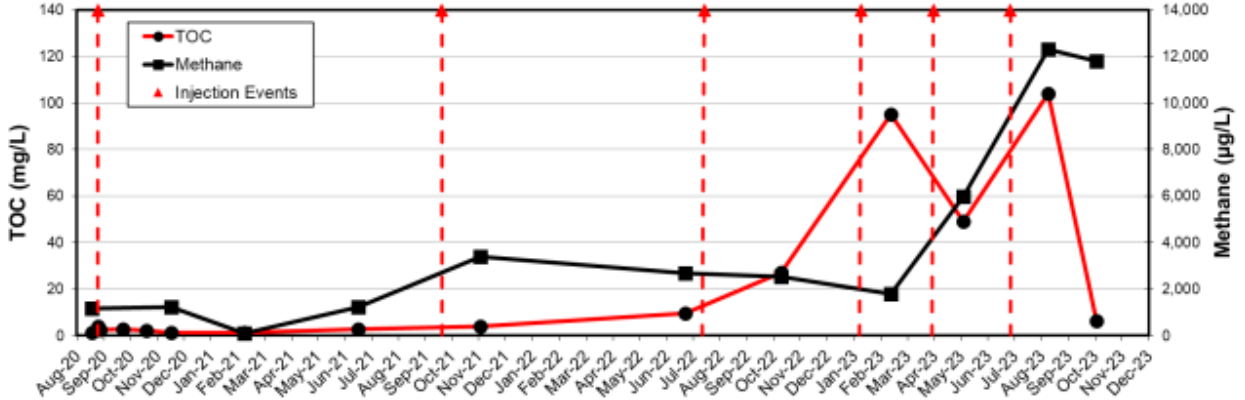
Methane Formation (Simplified) in ERD Systems



Methane Trends in Groundwater

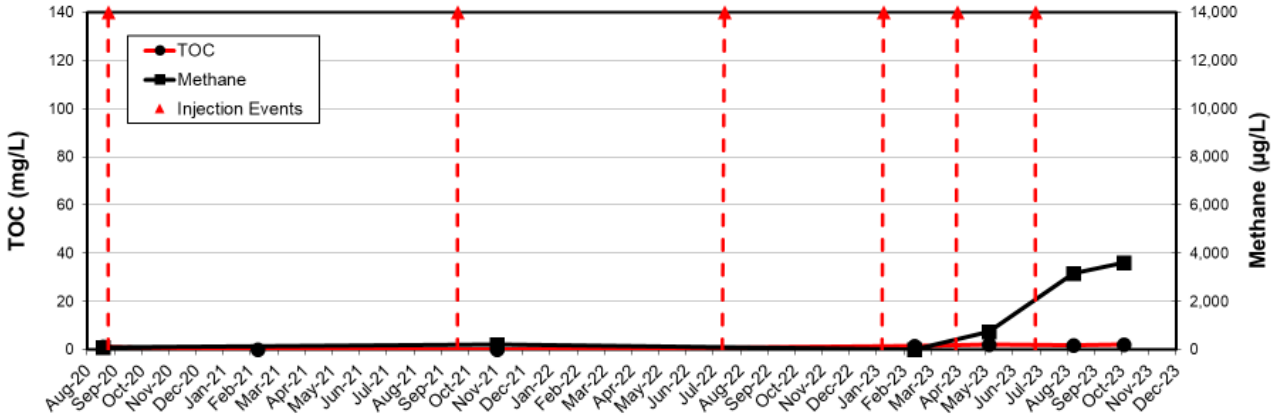
Within the Injection Zone

- Active methanogenesis
- Increasing trends with continued carbon injection



Downgradient of Injection Zone

- Outside influence of carbon injection
- Slow increase in methane over time
- Reflects methane migration from injection area



ERD Design Considerations

Methane Risk Mitigation

- Proximity to Buildings and Utility Corridors
- Injection/Monitoring Well Pressure Relief Valves
- Methane Monitoring Program
- SVE or SSDS

Image from waterra.com

Hazardous Area Classifications

SSDS Design Considerations

Class Definitions

CLASS	DEFINITION	GROUP EXAMPLES
CLASS 1	Flammable gasses or vapors	A: Acetylene
		B: Butadiene, Ethylene Oxide, Hydrogen, Propylene Oxide
		C: Acetaldehyde, Cyclopropane, Diethyl Ether
		D: Acetone, Ammonia, Benzene, Butane, Gasoline, **METHANE**, Propane, Alcohols

Division Definitions

Division 1

- Ignitable atmosphere may exist
  - Under normal operating conditions
  - Frequently because of leaks, or repair / maintenance

SSD Systems typically fall under **Division 2**

Division 2

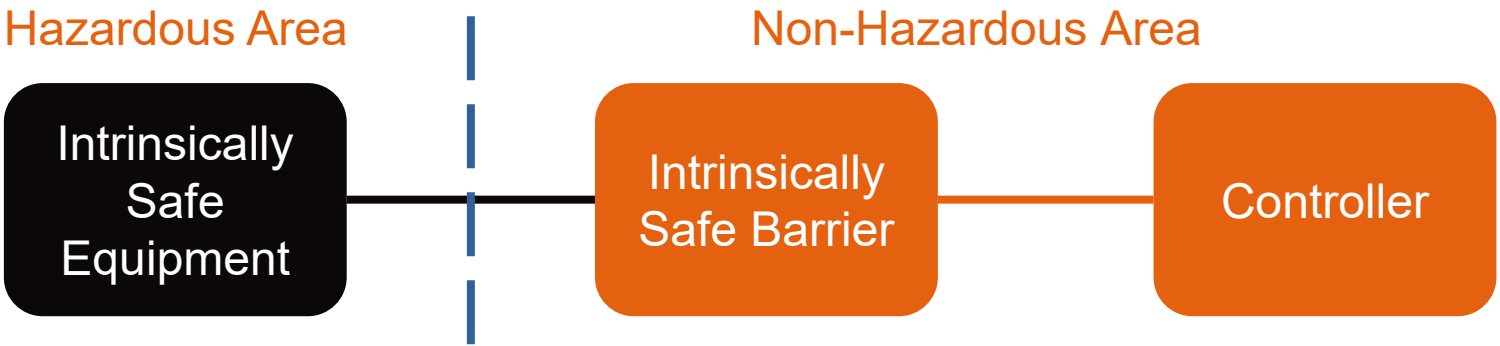
- Ignitable atmosphere may exist
  - Under abnormal operating conditions
  - Because of equipment breakdown, rupture or container failure
  - Because of migration from adjacent Division 1 areas
- When ignitable atmosphere is normally prevented by positive mechanical ventilation

Determining Area Classification

- Density
- Ventilation
- NFPA 497
  - Leak Source
  - <25% LEL
  - Experience with similar installations

Intrinsic Safety

- Electrical & Thermal Energy < Ignition
- General purpose instruments
- Reduces electrical installation costs
- Conductors must be separate from non-intrinsically safe conductors

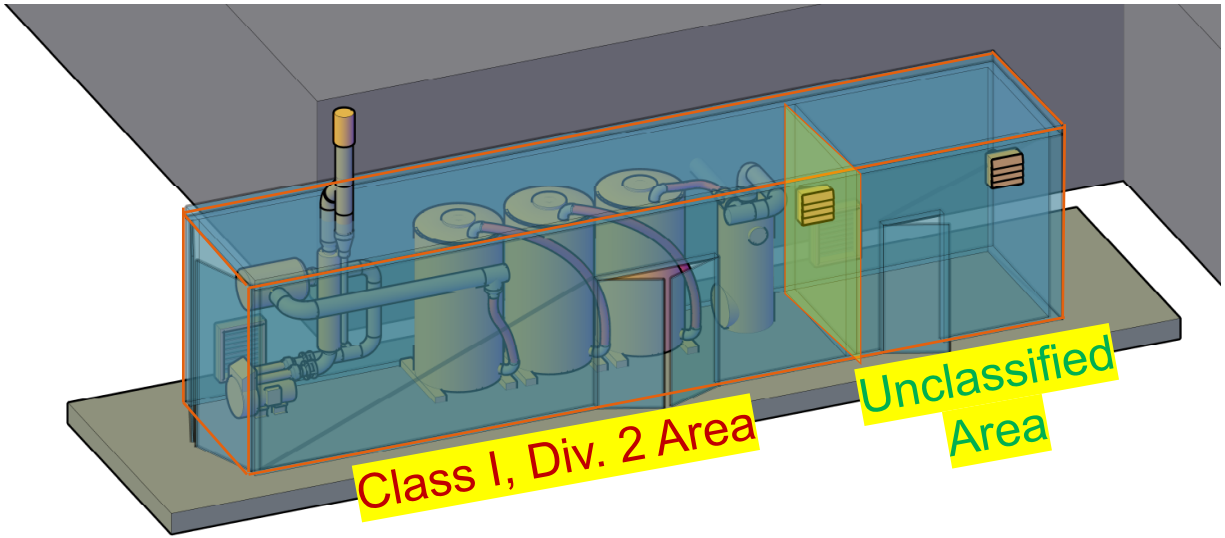


Cost Considerations

- Motors
- Instruments
- Fittings / Enclosures
- Labor

Example SSDS Design

- Classified Area Boundaries
- Intrinsically Safe Instruments
- Equipment Rated for Area
- Conduit Seals



SSDS Design Case Studies

Where Methane Is or May Be Present

Methane Mitigation System

Methane Data – Blower Operating vs. Not Operating

- Site with petroleum impacts degrading to methane
  - Methane was entering the building from the sub-slab
  - Methane exceeding the LEL was present in sub-slab
- SSDS reduced concentrations to 0.0% LEL
  - Flushing of sub-slab vapor
  - Recharging oxygen
  - Achieved depressurization
- Methane rebounds if system is not operated

Date	Monitoring Point MP-12	
	Vacuum *(in. H2O)*	Methane *(%LEL)*
1/2/2015	1.680	0.0
1/10/2015	1.190	0.0
1/17/2015	1.460	0.0
1/23/2015	1.420	0.0
1/31/2015	1.320	0.0
2/6/2015	1.460	0.0
2/13/2015	1.850	0.0
2/20/2015	2.010	0.0
2/27/2015	2.010	0.0
3/6/2015	1.430	0.0
3/11/2015(a)	0.000	0.0
3/17/2015(a)	**0.000**	**22.0**
3/18/2015	0.297	0.0
3/27/2015	0.695	0.0
4/3/2015	0.790	0.0

(a) Blower off

Methane rebound observed within 1 wk; and removed within 1 d of restart

SSDS – Proactive Design

Potential for Future ERD

- VOC impacts beneath building
- Class 1, Division 2 rated enclosure, includes all interior equipment
- Located control panels outside enclosure
- Installed seal offs at all electrical components located inside and outside enclosure
  - Flow transmitters
  - Vacuum switches
  - Blower
  - Exhaust fan
  - Lighting
  - Control panel
- Grounded all equipment

Rooftop Regenerative Blowers

Challenges

- Future ERD planned beneath building
- Multiple Tennant Building
  - Not allowed to install piping throughout to a single blower location
- Pilot test indicated high vacuum requirement
- Location – Denver, CO
  - Mile high elevation increased blower sizing
  - Seasonal operating conditions

Solutions

- Five Regenerative Blower systems
  - Class 1, Division 2 rated enclosure, including blower and vacuum transmitter
  - Electrical panel outside of enclosure
  - Seal offs on electrical conduit
  - Grounding of all equipment
- Custom rooftop enclosures
  - Angled design resists structural wind loading on roof
  - Doors open seasonally for ventilation eliminates need for XP rated exhaust fan
  - Insulation keeps sufficient blower heat in during winter

Summary

Safe Implementation of ERD

- Methane is more mobile than CVOCs and has different risks
- Mitigation of methane hazards should be considered during ERD planning
- Understanding NFPA requirements is important in designing systems to mitigate methane
- Proactively designing SSDS for Class 1 Div 2 reduces cost and potential delays implementation of ERD

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